C.M. Ginsburg and H.D. Glass
TD-05-033
30.March 2005

New Muon Lab Remanent Field Measurement

On 25.March 2005, we systematically measured the magnetic field in the New Muon Lab with a Hall probe. The measurement method and results are described.

We used a portable high-sensitivity Hall Probe (Group 3 LPT-231-7) with maximum measureable field of 3 kG combined with a digital Teslameter (Group 3 DTM-151). The manufacturer claims the measurement accuracy for this combination of probe/teslameter is $\pm 0.03\%$ at 25°C, with the finest resolution 0.01 G.

The coordinate system was chosen such that x points west, y points up, and z points north; we assume the building is oriented exactly along the geographical specification, with the long direction running North-South. The approximate geometry of the measurement within the New Muon Lab is shown in Fig. 1. The magnetic fields B_x, B_y, and B_z were measured by holding the Hall probe with the appropriate orientation. The magnetic field strength B was calculated as $B = \sqrt{B_x^2 + B_y^2 + B_z^2}$. Two types of measurements were taken: in a grid pattern throughout the building, and at fortuitously discovered locations with high fields.

The grid measurements were taken at an elevation of approximately $y = 4$ ft above the floor, in a 3×9 (x,z) grid pattern. The x grid points were (1) ~ 6 ft east of the west wall[1], (2) at the center of the building, and (3) ~ 3 ft west of the east wall[2]. The z grid points were at each steel building-support beam. The Chicago Cyclotron Magnet (CCM) is located in the region $2 < x < 3$ and $2 < z < 3$. The resulting magnetic field strength B map is shown in Fig. 2; the magnetic fields B_x, B_y, and B_z are shown in Fig. 3. The data points are shown in Table 1. The fields are strongest in the vicinity of the CCM, with the exception of the isolated high-field areas. The field component B_y is consistent with the Earth's magnetic field ~ -0.5 G far from the CCM. The point-to-point variations are found to be larger than the measurement reproducibility error, indicating the remanent fields depend on materials and their locations.

In addition to measuring this grid, we measured the fields at several isolated high-field locations, see Table 2. These locations are denoted with letters in Fig. 1. Note that this was not an exhaustive search. The highest measured field was at a steel building-support beam at $x = 3, z = 4$, where $B = 11.41$ G.

The finite power-cable length necessitated power cycling the probe/teslameter several times. The probe/teslameter were zeroed using a mu-metal shield the first few times after the equipment was power cycled, until we noticed that the reproducibility after the power cycle was better than that due to repositioning the probe. However, the measurements were found to be reproducible to within ~ 0.07 G. Therefore, the intrinsic probe accuracy is negligible for these measurements.

[1] center of the north-south clearance zone at the north-west end of the building
[2] center of the north-south clearance zone at the north-east end of the building

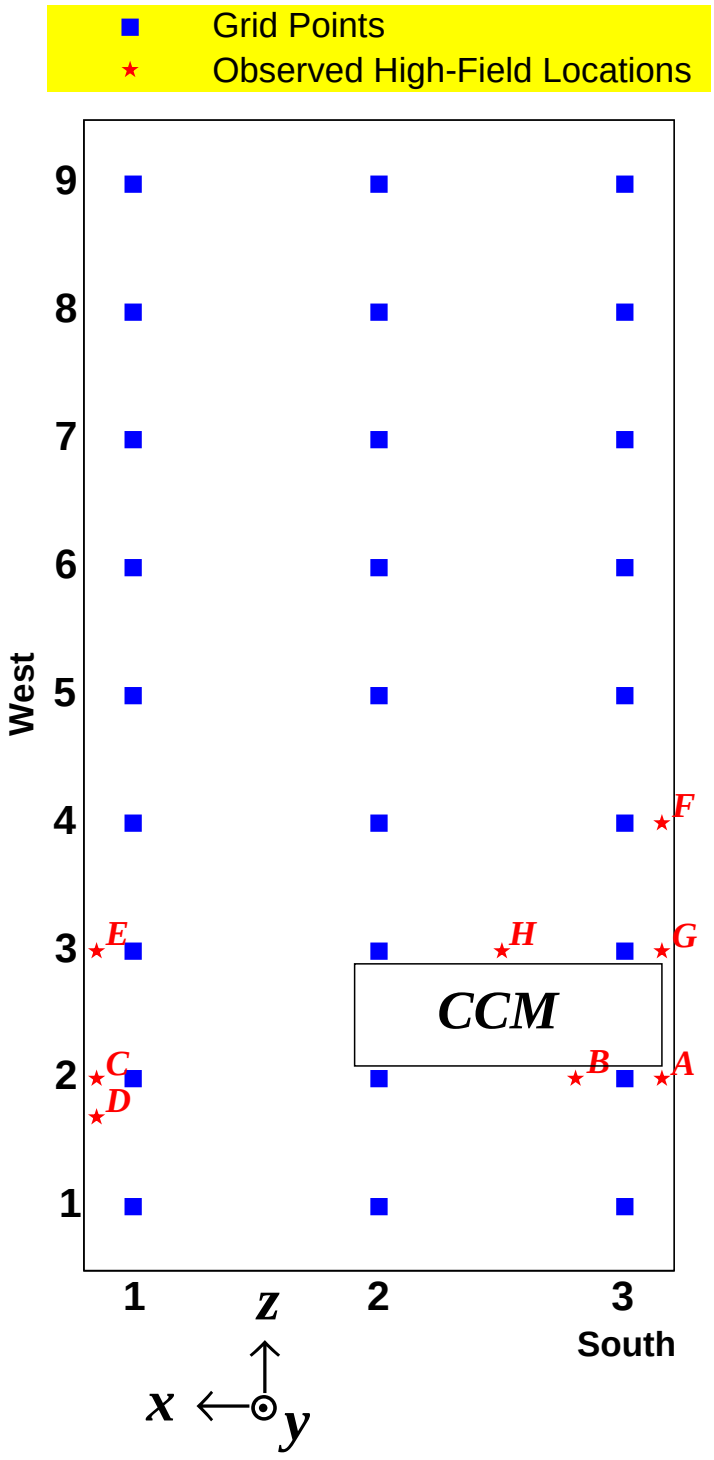

Figure 1: The geometry of the measurement within the New Muon Lab (not to scale).

Location (x,z)	B_x(G)	B_y(G)	B_z(G)	B(G)
(1,1)	-0.60	-0.18	0.33	0.708
(2,1)	-2.34	-1.71	-0.49	2.939
(3,1)	1.86	-1.33	0.74	2.403
(1,2)	0.21	-1.53	0.11	1.548
(2,2)	-0.48	1.38	-1.88	2.381
(3,2)	0.53	0.92	-0.74	1.294
(1,3)	0.66	-1.32	0.25	1.497
(2,3)	0.46	1.80	0.53	1.932
(3,3)	-0.14	1.52	0.39	1.575
(1,4)	0.06	-0.44	0.11	0.457
(2,4)	0.38	-1.32	0.15	1.382
(3,4)	1.87	-0.59	-0.11	1.964
(1,5)	0.03	-0.50	0.15	0.523
(2,5)	0.24	-0.51	-0.02	0.564
(3,5)	0.82	-1.04	0.21	1.341
(1,6)	0.57	-0.88	0.03	1.049
(2,6)	0.14	-0.48	0.37	0.622
(3,6)	-0.03	-0.64	0.14	0.656
(1,7)	0.36	-0.60	-0.42	0.816
(2,7)	0.15	-0.13	-0.06	0.207
(3,7)	0.11	0.19	0.09	0.237
(1,8)	-0.05	-0.65	0.08	0.657
(2,8)	0.13	-0.64	0.05	0.655
(3,8)	0.50	-0.61	0.10	0.795
(1,9)	-0.12	-0.09	-0.11	0.186
(2,9)	-0.17	-0.54	0.17	0.591
(3,9)	0.45	-0.27	0.08	0.531

Table 1: Measured grid locations.

Location (nearest x,z)	B_x(G)	B_y(G)	B_z(G)	B(G)
A: Building-support beam (3,2)	7.22	3.13	-0.74	7.90
B: CCM cryo-pipe (3,2)	1.88	1.60	6.35	6.81
C: Building-support beam (1,2)	-0.90	-1.58	-0.88	2.18
D: Stair railing (1,2)	-5.96	0.54	0.02	5.98
E: Building-support beam (1,3)	-1.22	-1.58	0.88	2.18
F: Building-support beam (3,4)	11.40	0.13	0.32	11.41
G: Building-support beam (3,3)	3.38	3.38	3.33	4.74
H: Brown chamber support (2,3)	-0.07	2.12	-0.76	2.25

Table 2: Measured high-field locations.

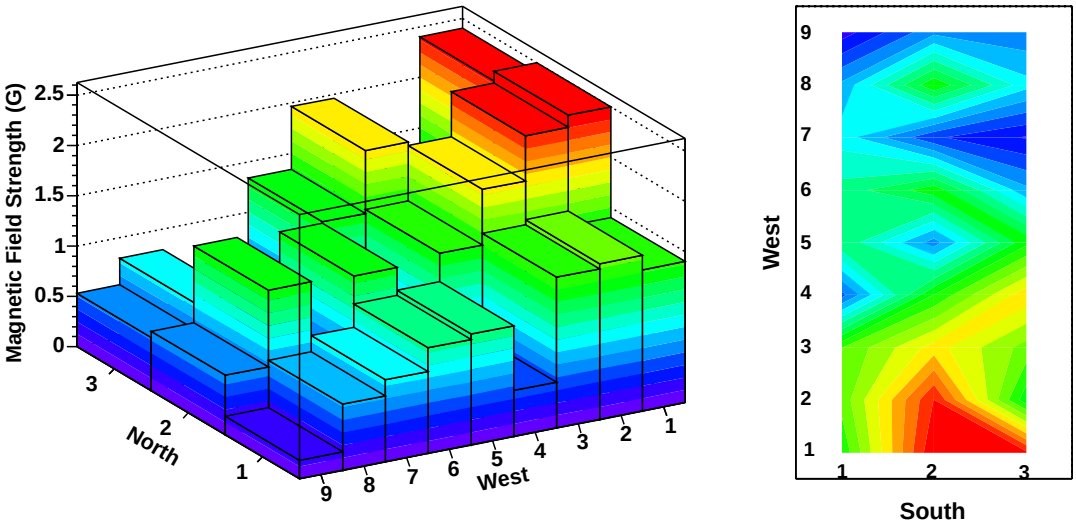

Figure 2: The grid magnetic field map for $B = \sqrt{B_x^2 + B_y^2 + B_z^2}$.

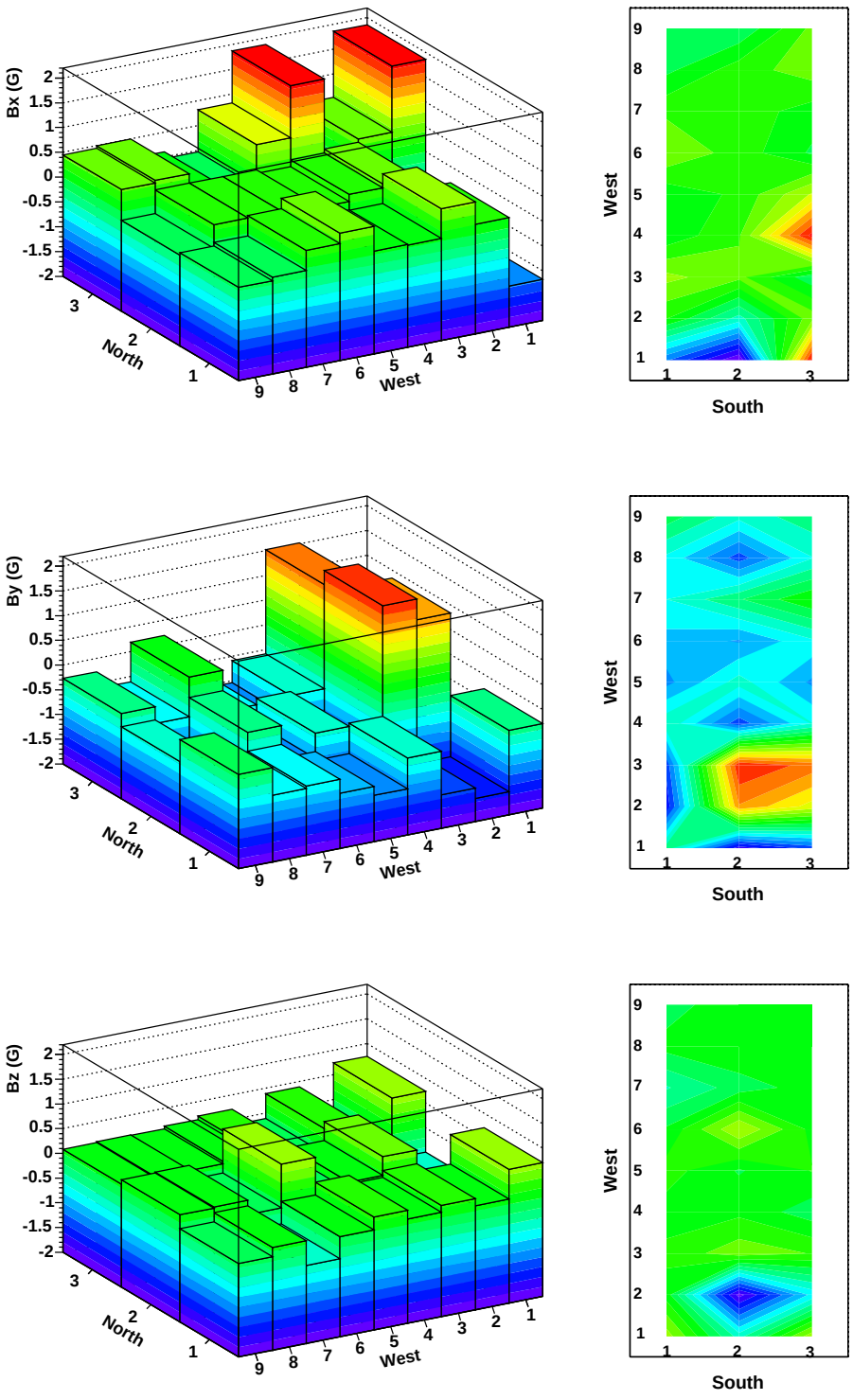

Figure 3: The grid magnetic field map for B_x (top), B_y (middle), and B_z (bottom).